THE CLIMATE OF NEW YORK STATE

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PRESENTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF CORNELL UNIVERSITY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

BY

RICHARD ALAN MORDOFF

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Reprinted from Bulletin 444, of the Cornell University Agricultural Experiment Station, October 1925

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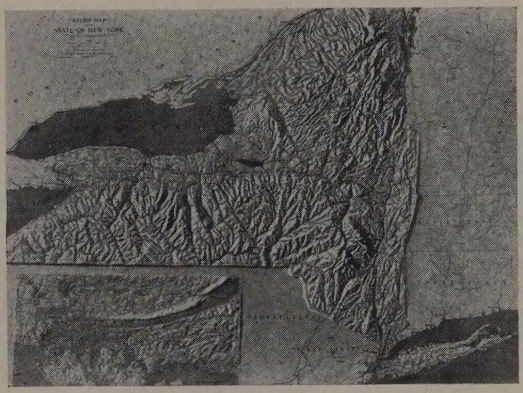
Bulletin 444 October, 1925

The Climate of New York State

R. A. Mordoff



Published by the
Cornell University
Agricultural Experiment Station
Ithaca, New York
Received for publication July 3, 1925

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THE CLIMATE OF NEW YORK STATE[1]

R. A. MORDOFF

The agriculture of a State is undoubtedly influenced more by its climate than by any other factor. In some sections, temperature and the length of the growing season determine the limits of growth of certain crops; in other sections, rainfall is the dominating influence; and in still others, sunshine is most important.

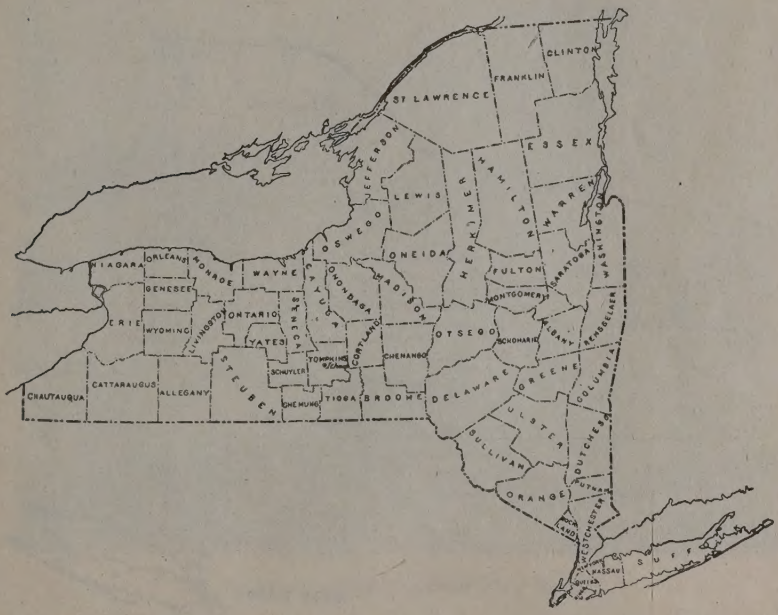

FIGURE 1. KEY MAP SHOWING LOCATION OF COUNTIES IN NEW YORK

Owing to its location in the belt of the prevailing westerly winds and to the diversity of its physical features, the several parts of New York State experience a variety of climates. As a result, practically all crops common to the temperate zone may be successfully grown within its boundaries.

Due to this diversity of climate in the State, it is not surprising that there is great popular interest in the weather, and hence that the first organization for local climatic observation in America was the one inaugurated in 1825 by the New York Board of Regents. This was continued

[1] Also presented to the Faculty of the Graduate School of Cornell University, August, 1921, as a part of a major thesis in partial fulfillment of the requirements for the degree of doctor of philosophy.

at several stations until 1863, when, with other scientific enterprises, it was abandoned because of the Civil War. However, the observations were continued at military posts, as well as by some private individuals, and reports were made direct to the Smithsonian Institution at Washington, D. C. In 1870 the National Weather Service was organized by an act of Congress, and five regular weather-observing stations were established in New York. Under the later administration of the United States Weather Bureau, the number was increased to nine regular stations. A key map of the counties of the State is here presented as figure 1, and the location of these observing stations is shown in figure 2.

FIGURE 2. UNITED STATES WEATHER BUREAU STATIONS IN NEW YORK

GENERAL CLIMATIC CONTROLS

In order to understand the climate of the State, it will be necessary to consider some of the fundamental controls of climate in general.

The principal factors that determine the general climate of a region in the intermediate zones of the earth are: (1) latitude, or the distance north or south of the equator; (2) altitude, or the elevation of the land surface above sea level; (3) distance and direction from large bodies of water; and (4) location of the place with respect to the normal path of storms.

The latitude determines the amount of heat energy, or insolation, received from the sun. Other things being equal, the distance north or

south of the equator would determine the temperature of a locality, because the sun's rays strike the earth at a greater angle with increasing latitude. In general, the average annual temperature decreases about one Fahrenheit degree for each degree of latitude traveled, either north or south of the equator.

The effect of altitude is to cause an average decrease in temperature of about one Fahrenheit degree for each 300 feet of ascent. For such a State as New York, with the elevation of its land surface ranging from sea level to more than 5000 feet (figure 3), this becomes an important

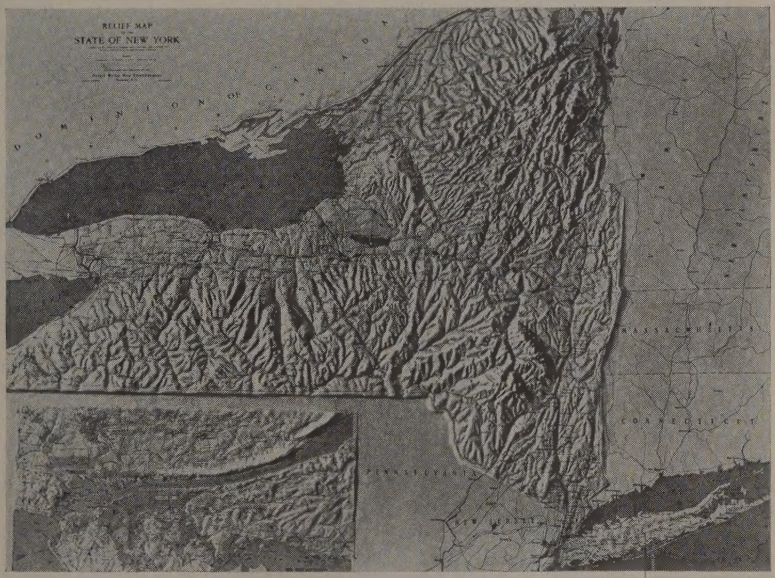

FIGURE 3. RELIEF MAP OF NEW YORK

influence in the local climate of many sections, as is clearly indicated by the wide difference between the temperature condition of the plateau divisions and that of the adjacent lowlands. Also, the elevated sections usually receive a heavier rainfall than do the lower areas. The air currents are forced to rise with the slope, and, as they rise, they cool because of the greater altitude and expand because of the decreased pressure; and, since the expansion itself involves a fall in temperature, the effect is to produce greater condensation and precipitation. This is especially true of slopes facing the prevailing winds.

It is a well-known fact that land heats and cools faster than does water. Therefore, temperatures over water areas are more equable than those over land areas, and, generally speaking, regions near large bodies of water are not subject to the sudden changes in temperature that are

experienced by localities farther inland. The location of the water mass with respect to the prevailing wind is even more important than is the distance. This is very well shown by a comparison of the temperatures of New York City with those of Eureka, California. Although the latitude and the mean annual temperature are practically the same for the two places, New York has an average annual range of temperature, between the warmest and coldest months, of about forty-three Fahrenheit degrees, while the average annual range at Eureka is only nine Fahrenheit degrees. The explanation of this wide difference is found in the influence of the prevailing winds. The temperature of Eureka is dominated by the prevailing westerly winds blowing from the Pacific Ocean. These winds are relatively warm in winter and cool in summer, due to the slow heating and cooling qualities of the water. On the other side of the continent, New York City is situated in the same prevailing westerly winds, but here they blow from the interior of the continent and are decidedly cold in winter and warm in summer.

The tempering effect of the Great Lakes is similar, except in degree, to that of the Pacific Ocean, and is plainly evident in the more equable climate of those parts of New York State bordering on Lake Ontario and on Lake Erie. The central lakes of New York exhibit the same moderating influence, but to a still lesser degree.

Cyclonic storms follow several fairly well-defined routes or tracks across the continent. Many of these storms have their origin in the western part of the United States and Canada, and are carried somewhat southeastward over the western half of the country, changing their course to northeastward when they reach a point a few hundred miles east of the Rocky Mountains. The farther southward a storm travels, the more pronounced is the turn to the northward in the Middle-Western States. Other storms originate in the Southwestern States, in the Gulf of Mexico, or in adjacent waters, and move northeastward. As a result, the majority of these storms either cross New York or pass so near it that their influence is felt over at least a part of the State.

The small destructive whirlwinds which are often incorrectly called cyclones are not cyclonic storms. Cyclonic storms are vast atmospheric disturbances covering perhaps as much as one-half of the United States at one time. Since these storms are in the path of the prevailing westerly winds, they move in a general west-to-east direction; and at the same time they have a rotary motion, counterclockwise in the northern hemisphere.

The winds blow from all sides spirally inward toward the center of the storm, ascending as they advance toward the center. Thus, to the east of the storm center the winds blow from an easterly or a southeasterly quarter, and to the west of the center from a westerly or a northwesterly quarter. Therefore, preceding these cyclonic areas of low pressure, the temperature normally rises, due to the indraft of warm air from the south or from over the ocean. After the storm center has passed and the wind has changed, the temperature falls rather rapidly because of the winds that come from the cooler areas to the north. Normally, a cyclone is accompanied by precipitation. The warm, moist air rising at the center of the low-pressure area is cooled by expansion, thus causing the condensation of the moisture contained in the air as vapor.

In the northern belt of the prevailing westerly winds, in which New York State is situated, anticyclones, or areas of high pressure, usually follow the cyclones and bring with them weather conditions just opposite to those that accompany the cyclones. The anticyclones move in the same general eastward direction as do the cyclones. This alternation of cyclones and anticyclones, with the accompanying wind changes, gives New York State its variable temperatures and a rainfall which is fairly well distributed throughout the year. Thus periods of extreme weather conditions of any kind are infrequent and of short duration over the entire area of the State.

These are the larger and more general climatic controls. The local aspects of the climate of New York are shown in detail by the climatological tables and charts presented in this bulletin.

THE CLIMATE OF THE STATE

New York State has a diversity of climate not usually encountered within an equally restricted area. In some respects nearly every locality has a climate of its own. This is due primarily to the varied topography of the State, and to its position between the Great Lakes and the Atlantic Ocean. Because of this diversity, and for convenience in discussion, the State has been divided into ten climatic divisions, or regions, as shown in figure 4. The lines that separate these divisions are, of course, arbitrary,

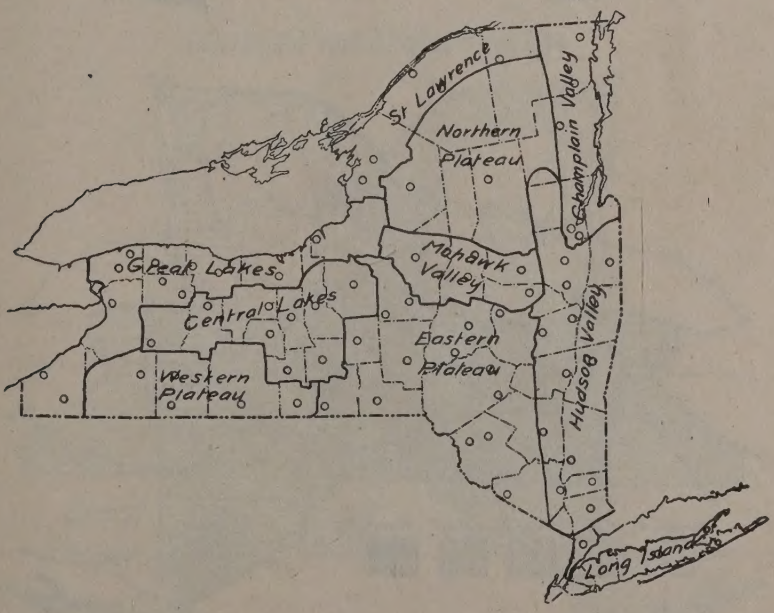

FIGURE 4. CLIMATIC DIVISIONS OF NEW YORK

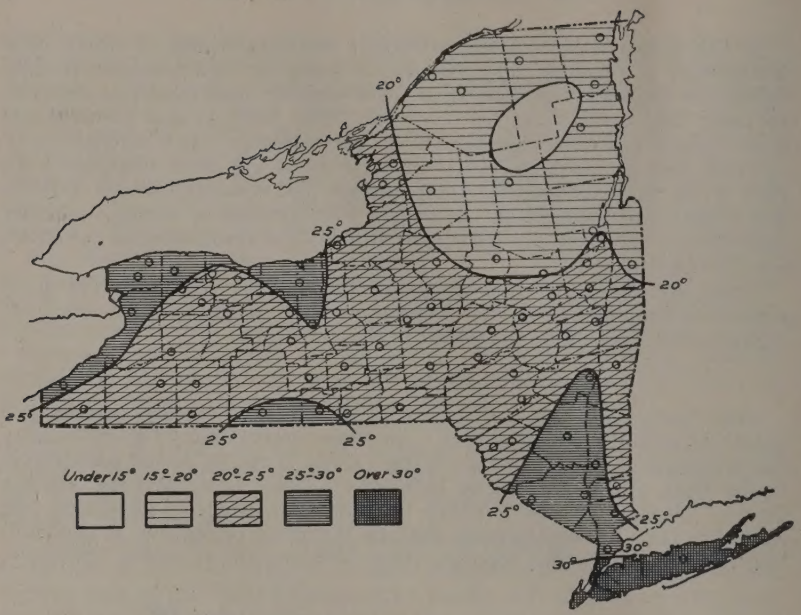

FIGURE 5. MEAN JANUARY TEMPERATURE

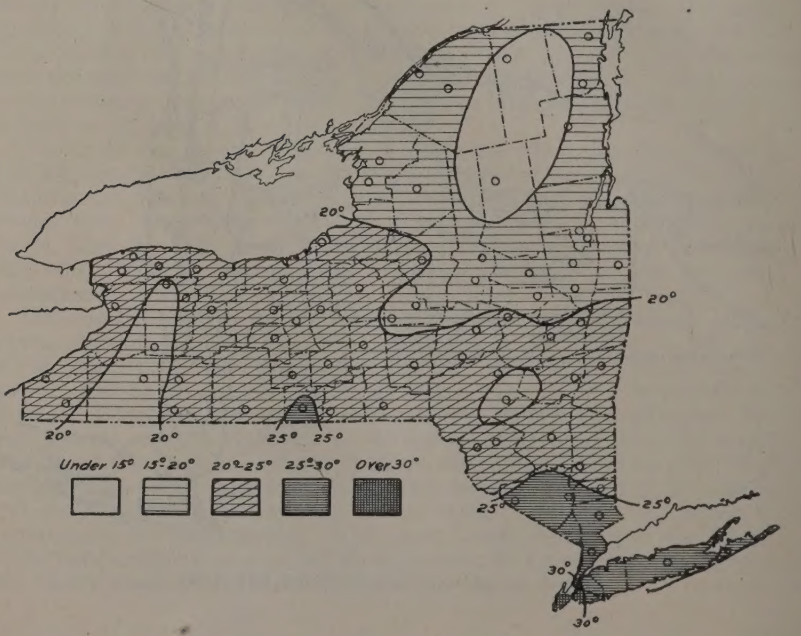

FIGURE 6. MEAN FEBRUARY TEMPERATURE

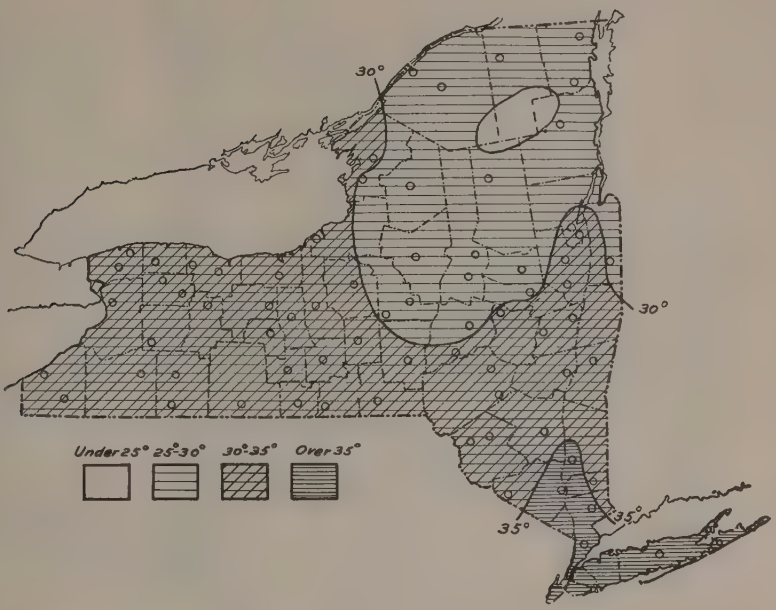

FIGURE 7. MEAN MARCH TEMPERATURE

FIGURE 8. MEAN APRIL TEMPERATURE

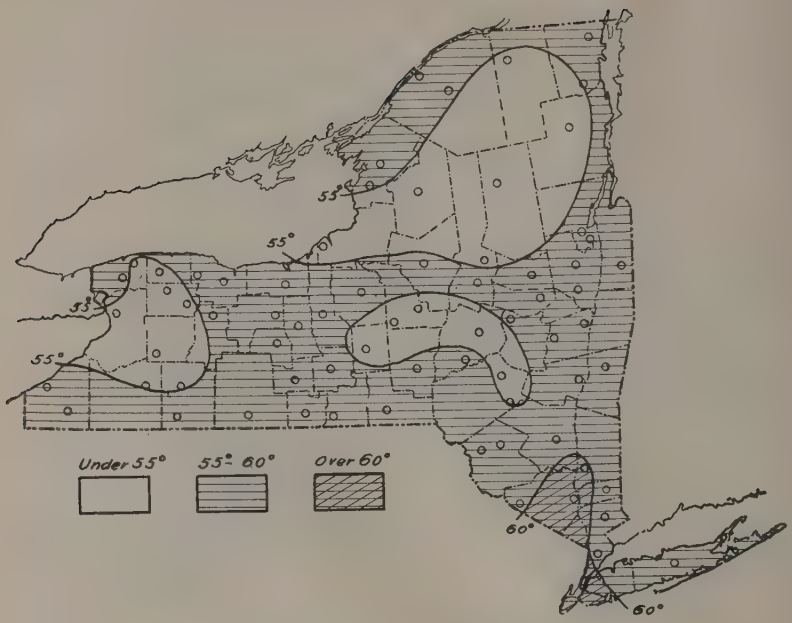

FIGURE 9. MEAN MAY TEMPERATURE

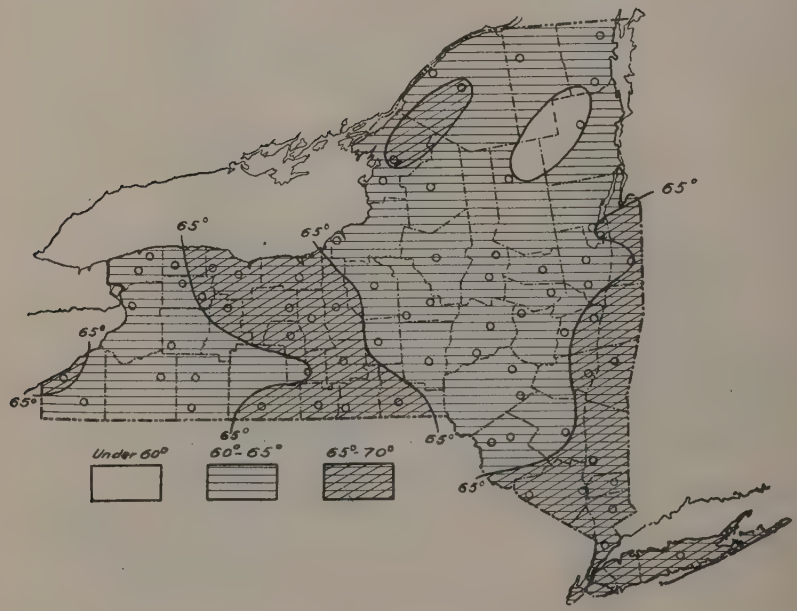

FIGURE 10. MEAN JUNE TEMPERATURE

FIGURE 11. MEAN JULY TEMPERATURE

FIGURE 12. MEAN AUGUST TEMPERATURE

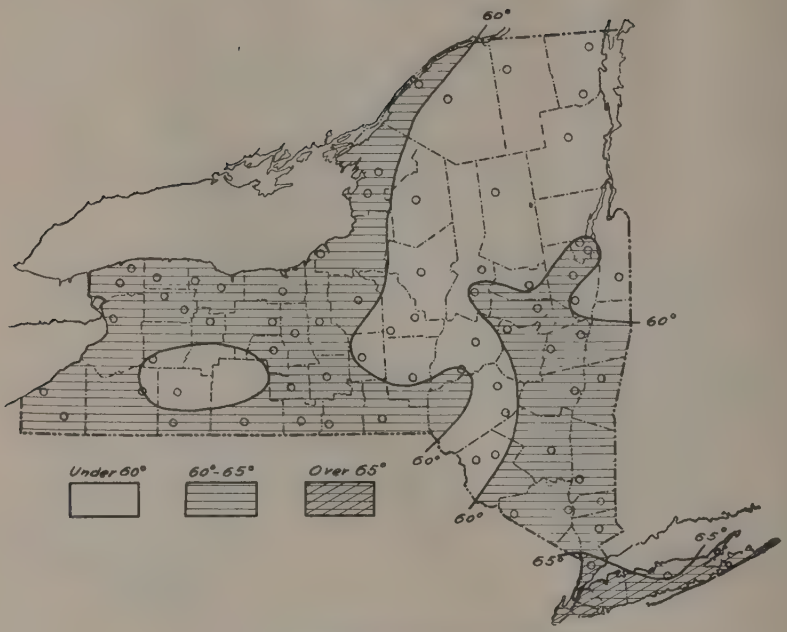

FIGURE 13. MEAN SEPTEMBER TEMPERATURE

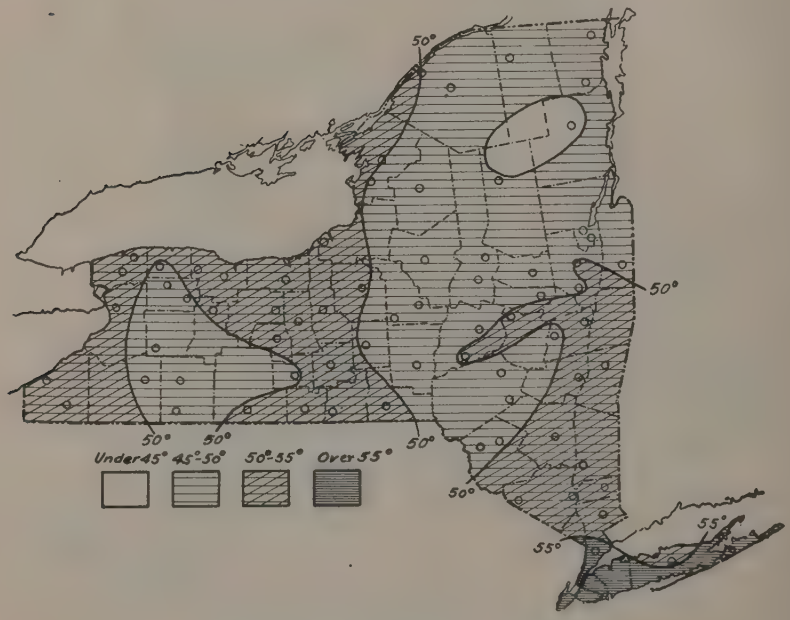

FIGURE 14. MEAN OCTOBER TEMPERATURE

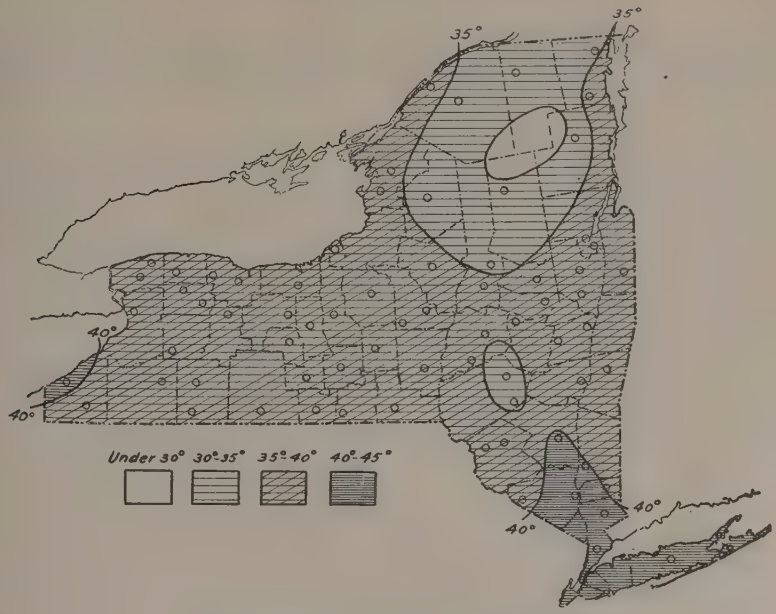

FIGURE 15. MEAN NOVEMBER TEMPERATURE

FIGURE 16. MEAN DECEMBER TEMPERATURE

and the changes of climate from one division to another are gradual. Nevertheless each division possesses certain general climatic features not common to the other divisions.

TEMPERATURE

The general distribution of temperature for the State, and the changes that take place from month to month, may best be indicated by charts showing the average temperature for each month. These charts, which are shown as figures 5 to 16, were made from the average monthly temperature records as reported by local observers to the Weather Bureau. In compiling and correlating the data relating to the various weather elements, consideration was given to the length, the continuity, and the apparent accuracy, of the individual record, as well as to the geographic location of the station.

The temperature of the Great Lakes division is largely influenced by the proximity of Lake Ontario, which borders it on the north, and of Lake Erie, which forms a part of the boundary line on the west. Lake Erie, lying directly in the path of the prevailing westerly winds, produces an important effect, especially over the land that slopes toward the west. The Chautauqua County grape belt, which extends along the southern shore of Lake Erie for a distance of about sixty miles and is from two to six miles wide, has the most equable climate in the State, except the region along the Atlantic Coast. This is directly due to the tempering influence of the lake, which holds vegetation in check in the spring until the danger from frost is over, gives long, mild autumns with unusually late fall frosts, and results in winters that are much less severe than are experienced in the more elevated sections a few miles to the east.

The effect of Lake Ontario in modifying the conditions along its southern border, while not so marked as that of Lake Erie, is important. When cold waves attended by low temperatures sweep down from the Canadian Provinces, the difference in temperature between the areas on the northern and those on the southern sides of the lake frequently amounts to twenty or more Fahrenheit degrees. Probably the most noticeable influence of Lake Ontario is over that part of the St. Lawrence division which lies between the lake and the Adirondack Mountains. Here the prevailing westerly winds that traverse the entire length of Lake Ontario produce their maximum effect, tempering the heat of summer and the cold of winter, except when the lake is frozen over. As a result, the springs are backward and cold but the autumns are comparatively warm. The winter season is severe, due to the frequency of storms and cold waves.

The plateau divisions present an almost typical continental type of climate. The elevation and the comparatively dry atmosphere combine to give high day temperatures, but the nights are decidedly cool owing to the rapid loss of heat by radiation. During the summer months the maximum temperature often reaches 90° F. or above. Winter begins early and continues severe throughout the season; temperatures of −40° F. are not uncommon in the more exposed localities.

Long Island and the Atlantic Coast exhibit conditions that are in marked contrast to those of the plateau divisions. The climate of the Long Island division is influenced more by the ocean than by the adjacent

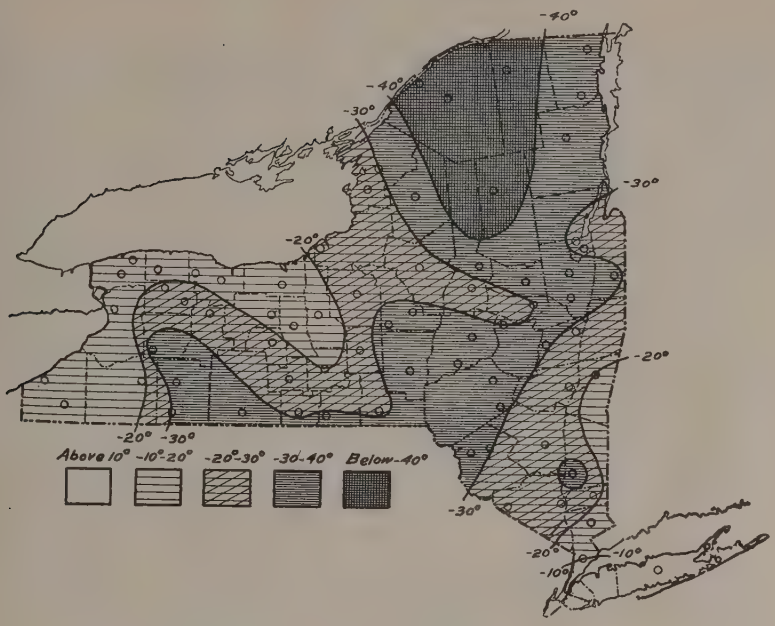

FIGURE 17. LOWEST TEMPERATURES RECORDED

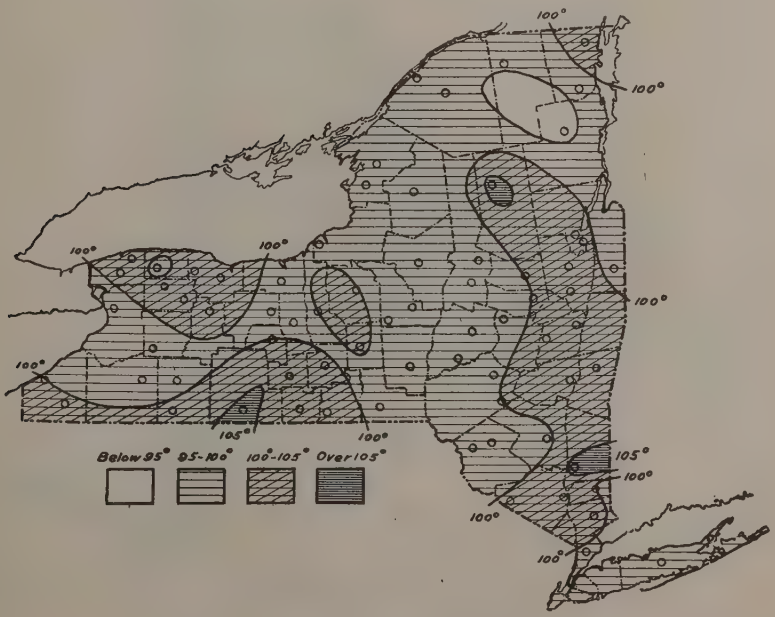

FIGURE 18. HIGHEST TEMPERATURES RECORDED

land surfaces, and is characterized by mild winters and relatively cool summers with comparative freedom from sudden and extreme changes of temperature.

Monthly and seasonal temperature ranges

During the month of January, which may be used to show the typical winter conditions, there is a greater range of temperature than at any other time of the year. The highest average temperature for the month, as indicated on the January temperature chart (figure 5), is a little above 30° F. in the Long Island division. The lowest average temperature for the same period is slightly below 15° F., and is found in the Adirondack Mountains. The low temperatures here are caused chiefly by the higher elevations and the distance from the ocean. The Western Plateau and Eastern Plateau divisions have about the same January temperature, varying from 20° to 25° F. The Great Lakes, Central Lakes, and Hudson Valley divisions have January temperatures about five degrees higher.

In July the lower temperatures are found in the higher altitudes of the mountainous divisions. The Northern Plateau and Eastern Plateau divisions have average July temperatures of approximately 66° F., while those of the Western Plateau division are about two degrees higher. The highest temperatures for the month are found in the lower Hudson Valley division and the Long Island division. These higher temperatures are due to the location of the divisions at lower altitudes and lower latitudes, and to the warm southwest winds which prevail during the summer.

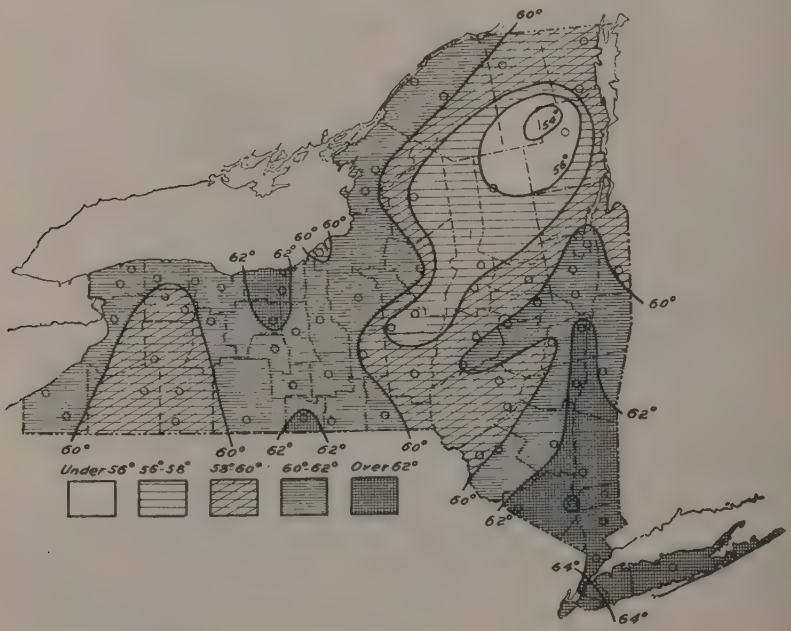

FIGURE 19. MEAN TEMPERATURES FOR GROWING SEASON

The charts of the mean temperatures for April and for October (figures 8 and 14) are somewhat similar, with the exception that the October temperatures are about five to ten degrees higher than those for April. Both of these months may be considered transition periods. The April chart shows the change taking place from winter to summer conditions, and the October chart shows the change from summer to winter conditions. The lowest temperatures recorded in the various parts of the State are shown in figure 17, and the highest in figure 18. It will be noted that very low temperatures have been experienced, −40° F. or lower, generally over the Northern Plateau, and that temperatures of 35° F. are not uncommon over the elevated parts of the Eastern Plateau and Western Plateau divisions.

The relative freedom from excessive cold along the Great Lakes, as well as a longer growing season, are undoubtedly the chief explanations for the successful fruit-growing in that section. Only Long Island and a small part of the adjacent coast enjoy greater freedom from excessive cold in winter than does this area bordering on these lakes.

The temperature during the growing months has a direct bearing on the kind of crops raised, as well as on the yields obtained. The average temperatures for the five growing months, April to August, inclusive, are shown in figure 19.

Frosts

The term *frost* is used to designate a deposit of ice crystals on the surface of plants or other objects, and also to designate temperatures that are injurious to vegetation. Weather Bureau observers use the term in the latter sense, and record three degrees of frost — light, heavy, and killing. Light frost is recorded when only the tenderest plants are injured; heavy, when the injury is more marked; and killing, when the staple crops of the region are killed or badly injured.

If, for any reason, the observer failed to note the dates of frosts, the date of the last freezing temperature, 32° F., in the spring, and the date of the first freezing temperature in the fall, are regarded as the dates of the last and the first killing frosts for the respective seasons. The accompanying charts, figures 20 to 22, show graphically the average date of the last killing frost in the spring, that of the first killing frost in the fall, and the average number of days between frosts. These dates are based on records made at about one hundred and fifty stations throughout the State. The charts, for the most part, are self-explanatory. It may be pointed out, however, that the average dates of frosts, as well as the average number of days between frosts, are simply arithmetical averages. For example, in the region along the east shore of Lake Erie, the average date of the last killing frost in spring falls on May 1, which means that in half of the years killing frost occurred before May 1 and in half of the years it occurred after May 1. It is obvious, therefore, that at the time of the average date as shown by the chart, the risk of frost is 50 per cent, which is entirely too great for tender crops. In the spring, the risk of frost decreases rapidly after the average date, falling to perhaps 30 per cent at the end of five days and practically disappearing at the end of fifteen days. In the fall, the frost risk increases rapidly as the average date of the first fall frost approaches, and is again 50 per cent at the time of the average date.

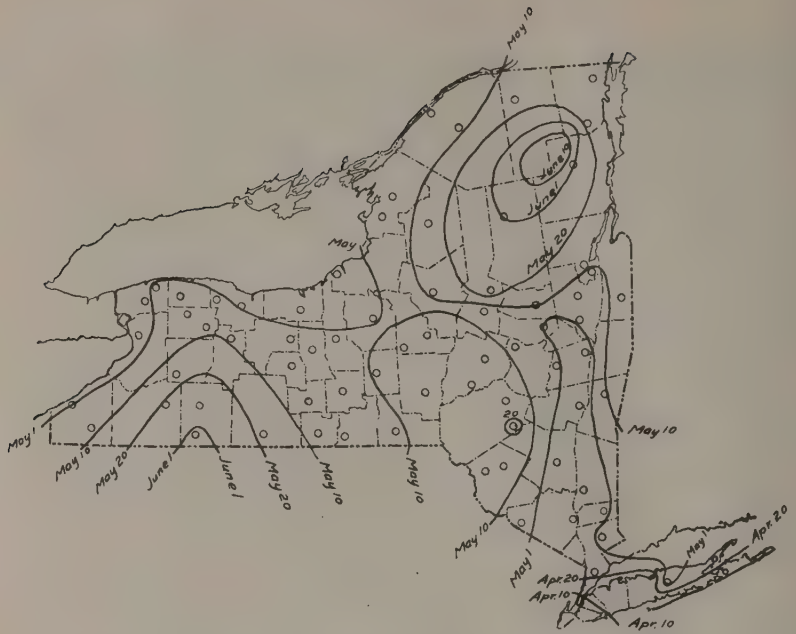

FIGURE 20. AVERAGE DATE OF LAST KILLING FROST IN THE SPRING

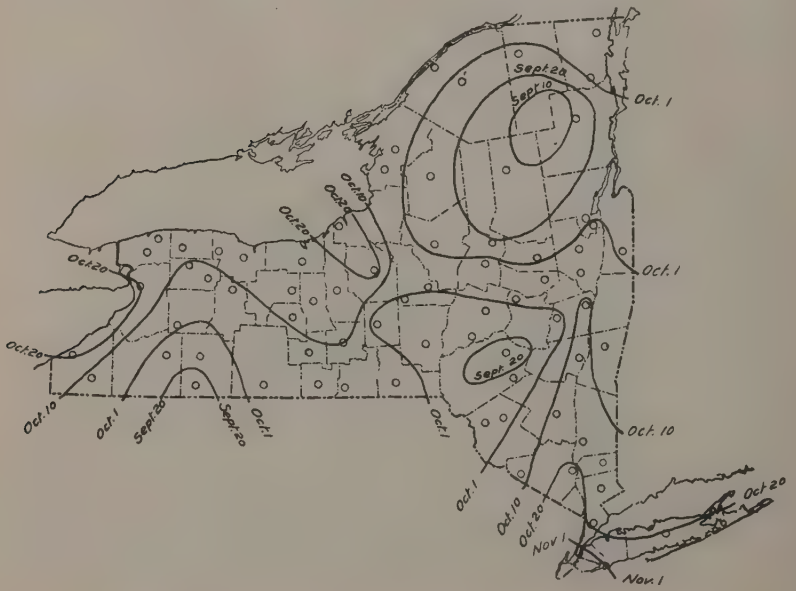

FIGURE 21. AVERAGE DATE OF FIRST KILLING FROST IN THE FALL

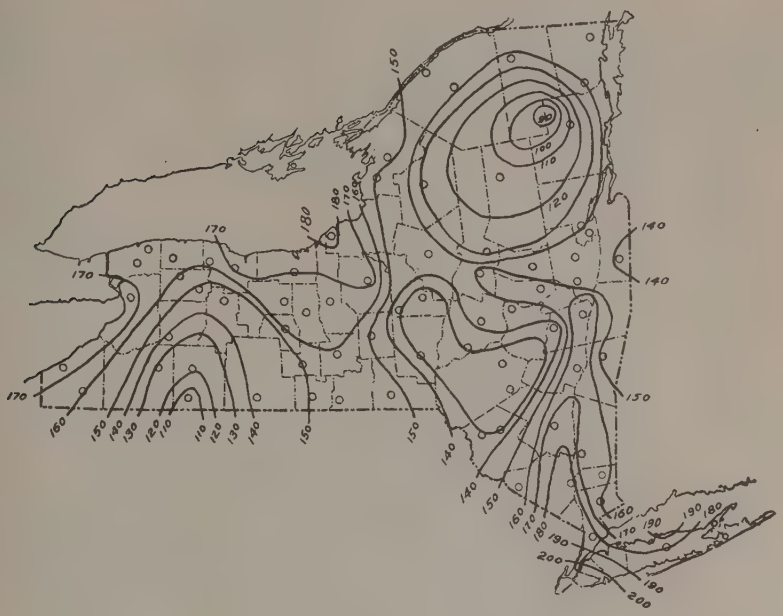

FIGURE 22. AVERAGE LENGTH OF THE GROWING SEASON, IN DAYS

With respect to the average length of the season between frosts, it should be noted that there are perhaps twenty days at either end of the season when frosts are likely to occur, and that the season of complete immunity from frost is about forty days shorter than the average as shown by the chart.

The effect of the Atlantic Ocean, of the Great Lakes, and even of the central lakes, is again very clearly shown by the fact that these sections have a much longer growing season than any of the plateau divisions. The plateau divisions must be content with a frost-free season of from one to two months shorter than that of the lake divisions. Long Island enjoys a growing season which is practically twice as long as in some sections of the Adirondacks.

PRECIPITATION

New York State is supplied with moisture principally by the winds that come from the Gulf of Mexico and from the Atlantic Ocean through the action of cyclonic storms. The general current of the prevailing westerlies plays but a small part in producing the rainfall of the State, except in so far as it accounts for the passage of the low-pressure areas.

The accompanying charts, figures 23 to 35, show the average annual and monthly precipitation. They are based on observations made daily at about sixty-five stations throughout the State. The records vary in length and also in the years covered, but no records covering a period of

less than fifteen years have been used in computing the averages. Several of the records cover a period of more than eighty years; a few, more than fifty years; and many, more than thirty years. Different types of rain gauges have been used in the series of records, but it is believed that no serious errors have arisen from this procedure.

Precipitation in the form of snow was reduced to its water equivalent by melting the snow and measuring and recording the depth of the water thus obtained. When it was impracticable to melt the snow, the water equivalent was recorded as one-tenth of the actual depth of the unmelted snowfall. If the snow is very wet or very dry, the error in applying this so-called "1-to-10 rule" is considerable; but when the method is applied to the snowfall of a season, which includes snowfalls of every character, or to those of many seasons, experience has shown that the error, so far as averages are concerned, is not serious.

Examination of the annual-precipitation chart (figure 23) brings out clearly the remarkably wide variation in the average amount of rainfall received in the different divisions of the State. In general, the average rainfall of the eastern half of the State greatly exceeds that of the western half, except possibly for the more elevated parts of Chautauqua and Cattaraugus Counties. For the Central Lakes division, including parts of Livingston, Ontario, and Yates Counties,[2] as well as for the western part of Niagara County and a part of the Champlain Valley division, the annual rainfall is the lightest in the State, slightly less than 30 inches annually. The heaviest precipitation, slightly in excess of 50 inches, is in the lower Hudson Valley division, including parts of Dutchess and Putnam Counties, and along the western slope of the Northern Plateau.

For the State as a whole, the winter season (December, January, and February) is relatively dry. By far the greater part of the State receives less than 9 inches of precipitation calculated as rain during these three months. The driest part of the State during the winter is the Champlain Valley division, with the remarkably low average of less than 5 inches. It is also dry in winter over most of the Central Lakes division. Over the southeastern counties, including Long Island, and over the greater part of the Mohawk Valley division, the winter rainfall is liberal, ranging in amount from 11 to more than 12 inches.

The average precipitation for the months of March, April, and May shows increased amounts and a somewhat more uniform distribution than that for the winter months, but the light precipitation persists over most of the Central Lakes division and over most of the Northern Plateau and adjacent divisions. For Long Island and the southeastern counties, and for most of the Mohawk Valley division, the precipitation is nearly the same as that for the winter months.

The summer (June, July, and August) rainfall is not only greater than that of any other season, but is decidedly more uniform in its distribution. The only parts of the State to receive less than a total of 9 inches during the three summer months are Niagara and Orleans Counties and a narrow belt along the St. Lawrence River. Nearly all the rest of the State receives more than 10 inches, a large part receives more than 11

[2] The location of the various counties of New York State are shown in figure 1, page 3.

inches, and considerable areas, particularly the Eastern Plateau and Western Plateau divisions and the lower Hudson Valley division, receive more than 12 inches, during these three months.

It is interesting to note that the precipitation for Long Island is less in summer than during either the winter or the spring season.

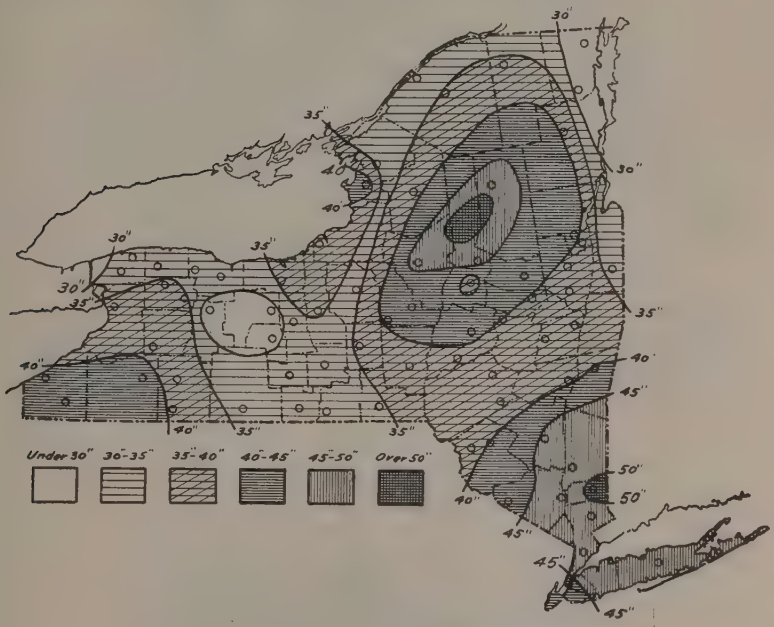

FIGURE 23. MEAN ANNUAL PRECIPITATION

The autumn (September, October, and November) is a season of light rainfall, particularly in the Central Lakes division and along the shore of Lake Ontario. Over all of this region the fall precipitation is less than 9 inches, and over much of it the average is less than 8 inches. Over most of the eastern half of the State the fall precipitation is liberal, ranging generally from 9 to more than 11 inches; a marked contrast to the conditions that prevail over the western half of the State.

In order to bring out more clearly the fact that spring is not the season of greatest rainfall, as is commonly believed, the mean monthly precipitation for the State is shown in table 1. This table indicates that July

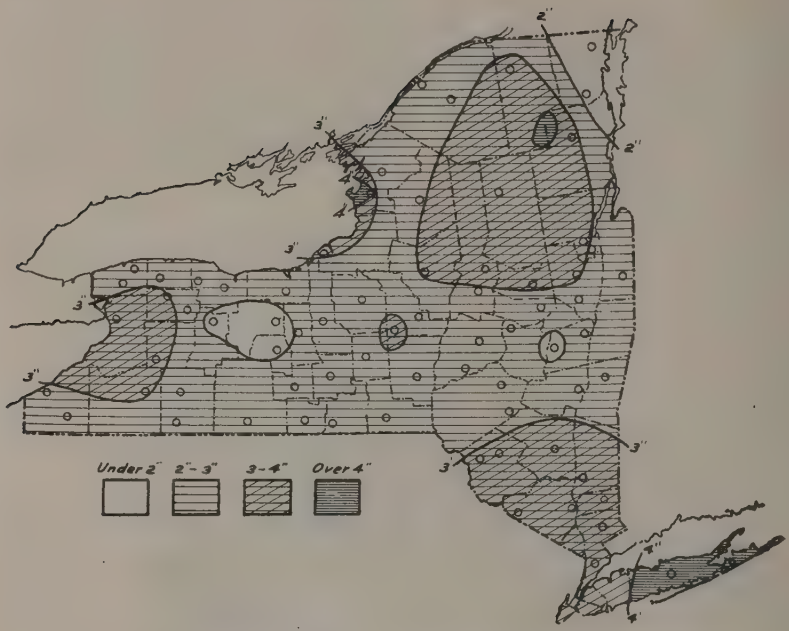

FIGURE 24. MEAN JANUARY PRECIPITATION

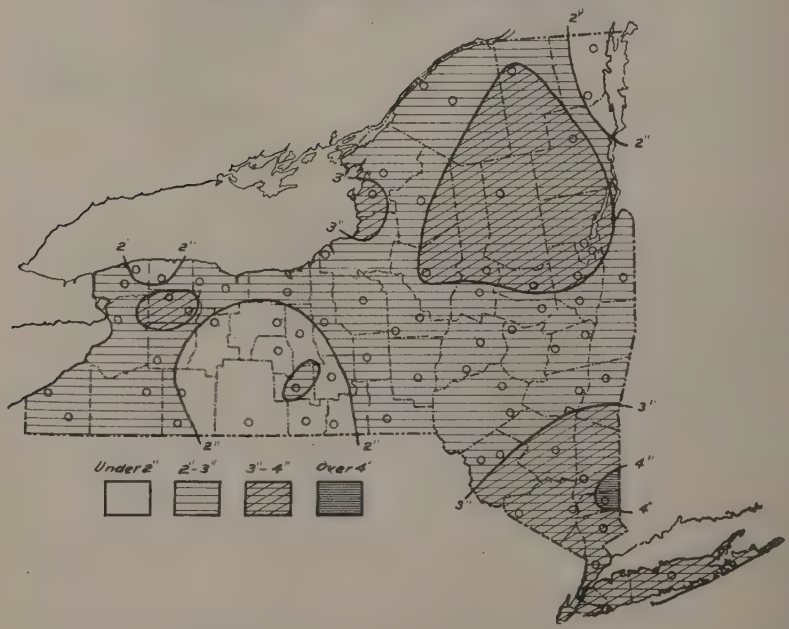

FIGURE 25. MEAN FEBRUARY PRECIPITATION

FIGURE 26. MEAN MARCH PRECIPITATION

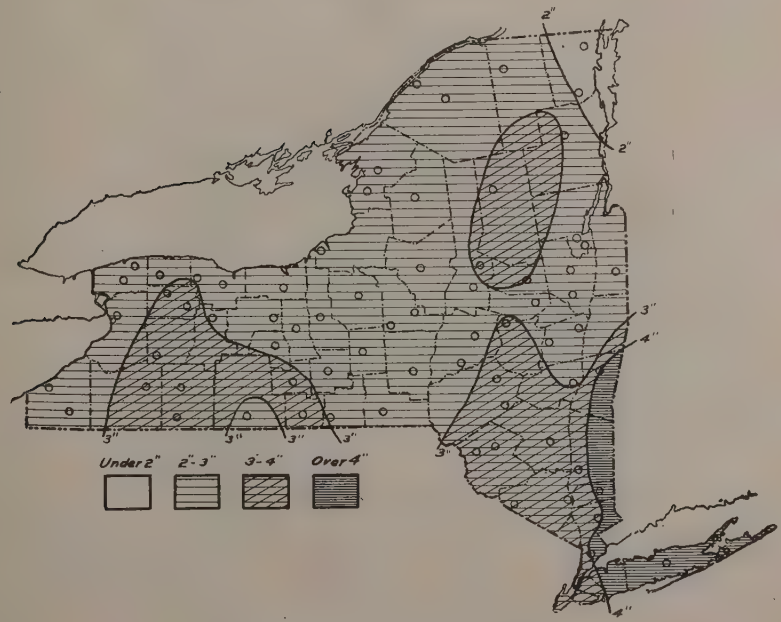

FIGURE 27. MEAN APRIL PRECIPITATION

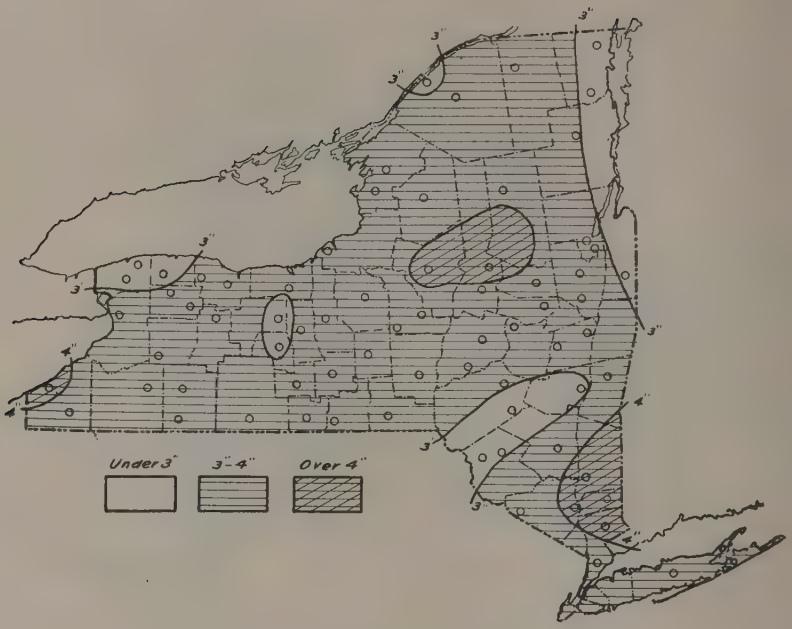

FIGURE 28. MEAN MAY PRECIPITATION

FIGURE 29. MEAN JUNE PRECIPITATION

FIGURE 30. MEAN JULY PRECIPITATION

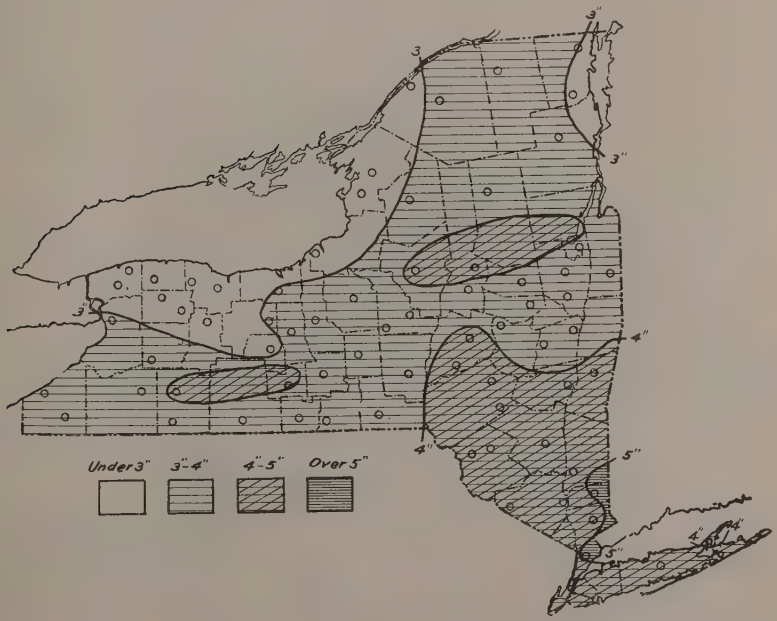

FIGURE 31. MEAN AUGUST PRECIPITATION

FIGURE 32. MEAN SEPTEMBER PRECIPITATION

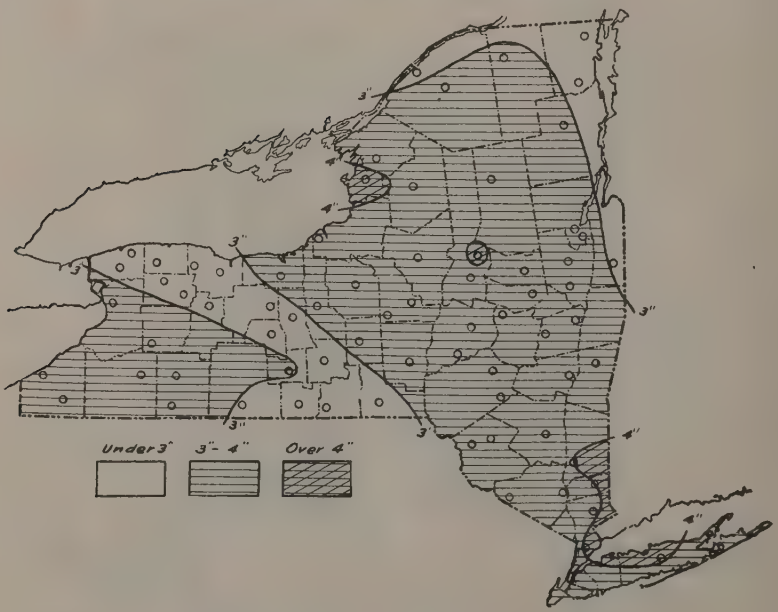

FIGURE 33. MEAN OCTOBER PRECIPITATION

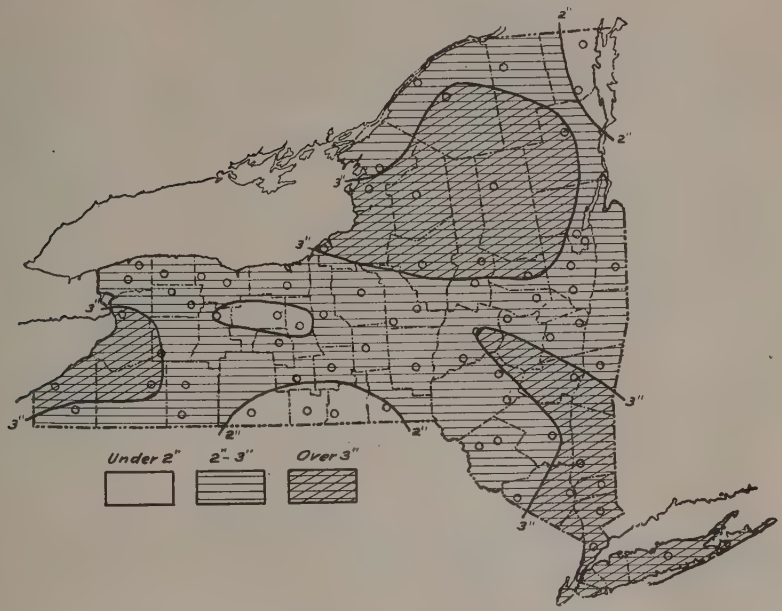

FIGURE 34. MEAN NOVEMBER PRECIPITATION

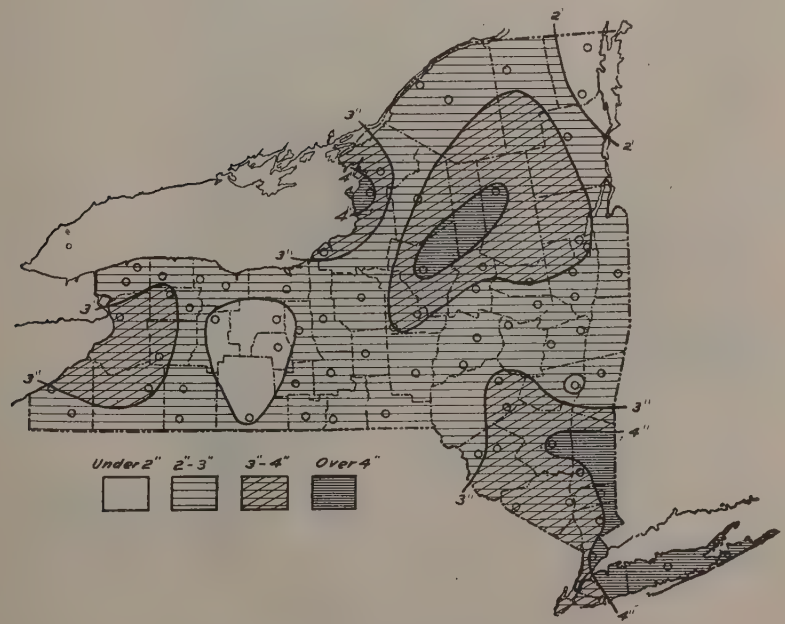

FIGURE 35. MEAN DECEMBER PRECIPITATION

TABLE 1. MEAN MONTHLY PRECIPITATION FOR THE STATE
(Average of sixty-five stations)

Month	Precipitation (inches)	Month	Precipitation* (inches)
January	2.88	July	3.87
February	2.68	August	3.68
March	3.06	June	3.61
April	2.89	May	3.45
May	3.45	October	3.40
June	3.61	September	3.28
July	3.87	March	3.06
August	3.68	December	2.97
September	3.28	April	2.89
October	3.40	January	2.88
November	2.71	November	2.71
December	2.97	February	2.68
Annual	38.48	Annual	38.48

* The same mean monthly precipitation arranged in the order of the heaviest precipitation.

and August, two months which are ordinarily thought of as dry periods, are in reality the two months of heaviest rainfall during the year. The heavy summer precipitation is due largely to thunderstorms, which

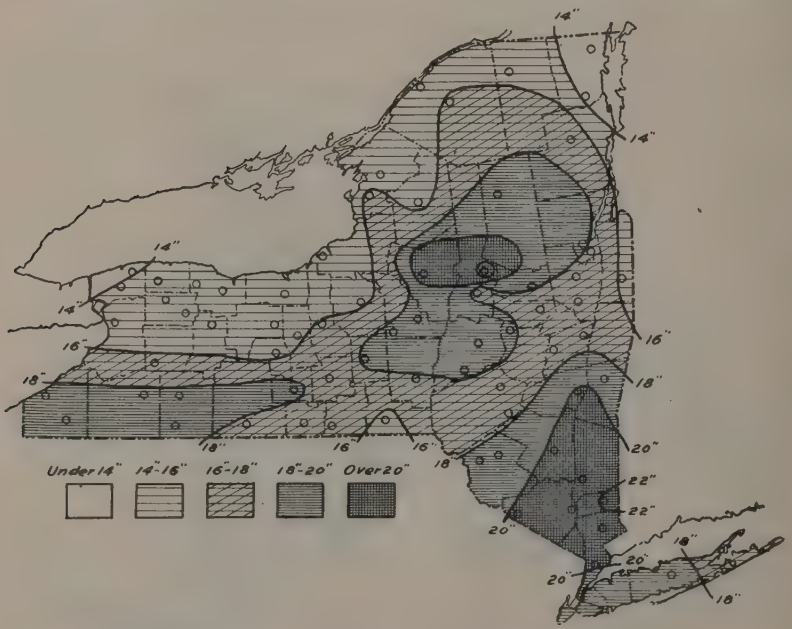

FIGURE 36. MEAN PRECIPITATION FOR GROWING SEASON

usually form quickly, cause heavy rains for a short time, and then pass on leaving the sky clear and the sun shining. April, with its proverbial "April showers," is one of the drier months, having over 25 per cent less rain than has July.

From the foregoing paragraphs, and from the rainfall map for the growing months (figure 36), it will readily be seen that New York State is exceptionally well favored by having a good distribution of rainfall throughout the growing season. This is of much more importance to agriculture than is the total annual rainfall, since moisture is thus furnished for plant growth at the time when it is most needed. Also, the smaller winter precipitation, principally in the form of snow, causes very little erosion or leaching of soil fertility such as would result if the heaviest rains came when crops were not on the ground.

It is often desirable to know the heaviest and the lightest rainfall that has been experienced at different places. The mean, the heaviest, and the lightest annual rainfall, as well as the mean, the heaviest, and the lightest rainfall for the crop-growing season (April to August), for sixty-five stations in various parts of the State, are shown in table 2:

TABLE 2. ANNUAL PRECIPITATION, AND PRECIPITATION FOR THE CROP-GROWING SEASON

Station	Annual			Crop-growing season (April to August)		
	Mean	Heaviest	Lightest	Mean	Heaviest	Lightest
Adams Center	44.53	65.40	32.82	16.97	27.47	9.98
Addison	33.79	40.51	25.84	17.73	23.23	10.96
Albany	37.64	56.78	26.39	17.73	35.97	9.34
Amsterdam	38.13	47.27	30.90	17.35	24.60	10.65
Angelica	37.98	52.07	28.02	19.41	25.15	9.71
Appleton	30.36	53.04	20.60	14.00	28.55	6.97
Athens	37.81	48.71	30.55	16.72	22.38	9.27
Auburn	36.63	49.82	21.74	17.34	24.29	10.33
Avon	28.67	35.47	19.35	14.78	18.95	7.70
Ballston Lake	35.91	45.54	30.07	16.33	25.56	11.72
Bedford Hills	46.13	68.98	35.36	20.46	39.44	15.89
Binghamton	33.30	42.62	22.42	15.94	24.03	6.38
Bolivar	39.73	48.64	31.75	19.33	26.97	12.90
Brockport	34.14	43.88	26.67	15.82	22.14	7.37
Buffalo	36.71	60.24	28.11	14.69	27.92	8.05
Canton	36.78	45.86	27.25	16.32	26.30	11.67
Carvers Falls	34.81	42.80	29.26	15.65	19.16	11.71
Chatham	40.52	51.04	26.50	19.79	29.61	11.18
Chazy	25.81	35.30	19.39	13.10	19.24	7.24
Cooperstown	40.73	58.11	29.90	19.63	28.58	12.13
Cortland	39.97	48.41	29.40	19.17	25.05	11.83
Cutchogue	45.76	57.44	34.70	17.77	24.35	13.06
DeRuyter	41.09	48.48	34.45	18.97	24.22	13.84
Elba	36.98	45.30	30.53	15.87	21.66	9.42
Elmira	33.69	40.08	25.47	17.50	23.27	9.56
Franklinville	41.25	49.60	31.34	19.31	25.48	11.66
Geneva	29.08	42.01	19.35	15.47	22.67	9.72
Glens Falls	39.53	53.86	31.88	16.75	27.85	8.70
Gloversville	43.57	56.62	34.59	19.04	28.54	10.44
Greenfield Center	39.64	47.84	33.41	16.46	22.27	10.20

TABLE 2 (*concluded*)

Station	Annual			Crop-growing season (April to August)		
	Mean	Heaviest	Lightest	Mean	Heaviest	Lightest
Griffins Corners	39.35	51.35	30.84	17.69	26.17	10.01
Harkness	26.66	39.96	19.62	13.18	18.70	9.13
Ithaca	32.99	46.39	21.20	16.19	24.75	8.67
Jeffersonville	39.49	52.43	34.51	18.13	26.18	10.35
Lake George	42.16	53.86	35.76	18.43	29.91	9.00
Lake Placid Club	41.71	48.31	37.45	17.61	21.83	15.06
Little Falls	38.12	46.62	28.74	17.93	23.28	10.86
Lockport	31.13	46.48	17.57	14.15	23.72	3.78
Lowville	36.23	48.61	26.47	15.67	25.03	10.48
Lyons	36.46	45.66	27.04	16.79	23.42	10.60
Medford	46.37	56.37	37.87	19.43	25.35	14.69
Mohonk Lake	47.92	60.75	35.14	21.07	36.83	14.10
Moira	37.29	49.35	31.14	15.89	23.36	12.05
New York	44.04	58.68	33.17	19.26	30.32	12.87
Ogdensburg	31.63	38.81	24.15	14.41	17.25	7.34
Oneonta	38.20	57.64	29.84	18.47	28.99	10.10
Oswego	36.56	56.16	23.41	14.71	24.85	7.31
Oxford	37.97	60.63	29.13	17.83	28.75	11.19
Penn Yan	28.82	44.36	19.66	14.77	26.87	9.76
Port Jervis	43.95	60.05	31.90	20.43	31.03	13.97
Raquette Lake	45.30	55.03	34.73	18.90	29.50	11.79
Rochester	33.31	49.89	20.30	14.74	19.57	8.68
Rome	48.24	66.84	32.70	20.88	26.93	12.48
Romulus	31.12	43.20	22.22	15.56	22.55	9.10
Salisbury	48.38	59.26	34.29	22.49	29.99	13.90
Scarsdale	47.87	59.69	36.25	21.08	31.18	15.18
Setauket	46.18	59.26	33.57	18.29	34.73	10.64
Sharon Springs*	39.12	43.80	36.55	18.43	25.24	16.96
Syracuse	33.76	44.54	26.96	15.73	21.80	10.01
Wappingers Falls	48.00	82.06	34.65	21.69	47.86	12.16
Watertown	34.69	44.80	27.19	14.55	24.40	10.56
Wedgewood	37.20	48.48	29.44	18.66	26.61	11.50
West Berne	34.41	44.91	26.08	16.88	24.13	12.84
Westfield	40.24	50.68	31.39	18.08	23.68	11.71
West Point	46.03	63.56	30.64	20.76	37.75	10.48

* Seven-years record only.

Snowfall

The most serious error in the records is undoubtedly in connection with the measurements of precipitation in the form of snow. This has always been a difficult problem, and even under the most approved methods of calculation there is a considerable error when high winds prevail and there is much drifting. A study of the earliest records for the winter months indicates that, as a rule, the amounts recorded from snow were probably somewhat less than the true readings.

The average annual snowfall for the State as a whole is about 65 inches, but it varies greatly in different parts of the State. The Adirondack Mountains have the heaviest and Long Island has the lightest snowfall, as is shown by figure 37.

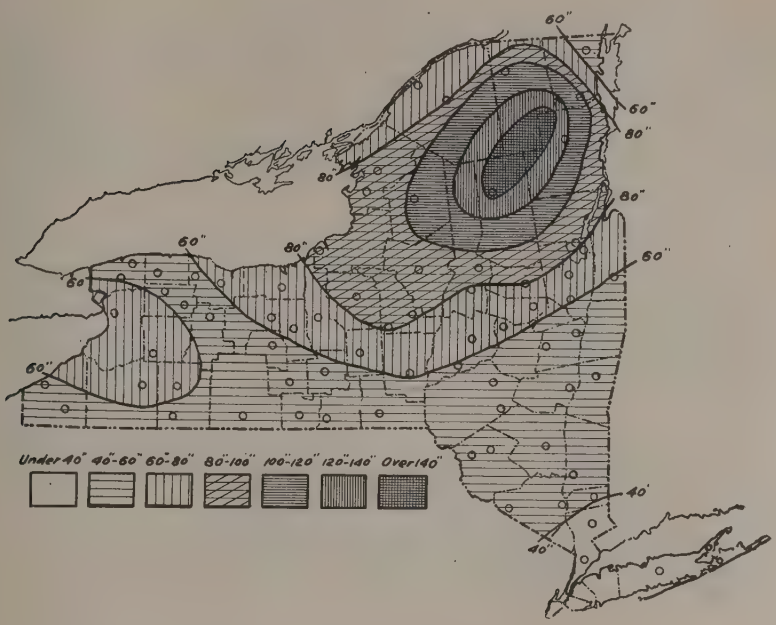

FIGURE 37. MEAN ANNUAL SNOWFALL

Snow occurs usually from October to April, inclusive, but it has been recorded both in May and in September. The greatest average snowfall is in the month of February.

Droughts

A serious and long-continued deficiency of precipitation affecting the State as a whole, is of rare occurrence in New York. There have been many short periods when crops suffered from a deficiency of moisture, and many occasions when a moisture shortage was confined to one or more sections; but there have been only a few state-wide droughts.

Perhaps the two most serious droughts in recent years were those in 1889 and 1908. In 1889 the total rainfall for the months of June, July, and August, which normally is about 12 inches, averaged somewhat less than 6 inches for the entire State, except for the extreme southeastern counties and Long Island, where it was normal or above. As is usual, the western part of the State suffered more than did the eastern part, the total rainfall for the three months in some localities bordering on Lake Ontario being less than 3 inches. The drought of 1908 occurred later in the season, beginning on August 23 and continuing, with the exception of a slight break on September 28 and 29, until October 23, a period of sixty-one days. During a period of thirty-five days, from August 23 to September 27, there were thirteen days on which no rain fell at any of the one hundred and twenty-five recording stations in the

State, and seven days on which there was a light shower at only one station. The water supply for most cities and towns, particularly in the interior, was greatly reduced, and in some places was entirely exhausted.

A drought lasting forty days occurred in April, May, and June, 1903, and another of about fifty days in the same months in 1913. Since they came early in the season, when the loss by evaporation was not great, and since they were followed by copious rains during the latter part of June, the results were not serious.

Thunderstorms

Thunderstorms are more frequent in the Hudson Valley and over Long Island than in other parts of the State, the average number being about twenty to thirty annually. They are also frequent along Lake Erie and Lake Ontario; Buffalo reports as many as fifty-five in a single year. They are less frequent in the northern part of the State and in the interior; the average number reported annually in these sections ranges from six to fourteen.

Hail.— True hail is a product of thunderstorms, but fortunately relatively few thunderstorms produce hail. Of the twenty to thirty thunderstorms that occur annually in the Hudson Valley and over Long Island, only about three or four cause an appreciable fall of hail. For the remainder of the State, hail probably occurs at most places on an average of one or two times in the course of the year, but rarely does it cause any widespread destruction.

TORNADOES

Tornadoes are local whirlwinds of destructive violence, characterized by a funnel-shaped cloud that hangs pendent from the overhanging storm cloud. The path of destruction ranges in width from a few feet to perhaps half a mile, and in length from a few yards to several miles. New York suffers comparatively little from these storms, but no part of the United States east of the 105th meridian may be regarded as entirely secure from their visitation. However, they are more frequent over the Middle-Western and the Southern States than over New York.

Several separate and distinct tornadoes occurred within the State during the year 1888. These storms were widely distributed from the northern to the southern boundary, rather than being confined to the southern tier of counties as is usually the case.

In more recent years, perhaps the most notable storm of this character to visit New York passed over Binghamton at about half past ten o'clock in the evening of June 5, 1905. Its path was from 200 to 600 feet in width and somewhat more than a mile in length. Many trees were uprooted or twisted off, and a number of houses were destroyed; but there was no loss of life.

WINDS

The prevailing winds of the State are westerly, generally shifting toward the north in winter and toward the south in summer. At some points, as Albany, Oswego, and Cooperstown, the southerly winds of

summer persist throughout the fall and even into December and January. At other points, chiefly in the mountainous sections, local topographic conditions control the wind direction, so that the prevailing direction is merely that of a local current. At Ithaca the prevailing direction for the entire year, except in the spring months, is from the southeast, due principally to the trend of the valley at the southern end of Cayuga Lake.

The so-called " night wind " of the Cayuga Lake Valley is interesting, and serves as an example of the effect of local topography. It blows during the summer months at times when the absence of cyclonic disturbances gives full play to local influences. Commonly it sets in a few hours after sunset as a light breeze from the south, gradually increases in strength until a velocity of about eight miles an hour is reached, and thus continues steadily throughout the night. This current has its origin on the hillsides at the southern end of the lake, and it flows northward down the watercourses converging into the main depression. As it moves northward over the smooth surface of the lake, it is augmented by the numerous cool currents which join the main stream through the watercourses that debouch upon the valley from either side.

The night wind is air drainage on a large scale, the result of surface cooling when the heat from the sun is withdrawn. Winds of this character occur in other parts of the State where the local topography is similar.

Observations of wind velocity are available only for the nine regular Weather Bureau stations in the State. The highest velocity for the State, ninety-six miles an hour from the southwest, was recorded at New York City, and velocities of ninety miles an hour, or more, have been recorded at various times.

The highest velocity recorded at Buffalo was ninety-two miles an hour from the southwest, but velocities of ninety miles an hour have been recorded at that station on several occasions. In other parts of the State, velocities exceeding seventy miles an hour are rare.

SUNSHINE

It is obvious that with a clear sky the actual amount of sunshine for any given place would be the number of hours between sunrise and sunset. This is called the *possible sunshine*. It varies greatly with the season, reaching its maximum in June and its minimum in December. It varies also with the latitude, but the variations from this cause within the limits of New York are so slight that, so far as effect is concerned, the possible sunshine for all places within the State may be regarded as essentially the same.

The actual amount of sunshine in hours is recorded automatically at eight Weather Bureau stations in the State, and from the data thus obtained average daily and monthly values have been computed. For the State as a whole, sunshine and cloudiness during daylight hours are about evenly divided, except for the Atlantic Coast division, where the average amount of sunshine is about 60 per cent of the possible. There is less sunshine over the south-central counties than elsewhere in the State. Binghamton has only about 40 per cent of the possible.

New York ranks considerably below the Central and Western States in the amount of sunshine. It lies well within what may be called the

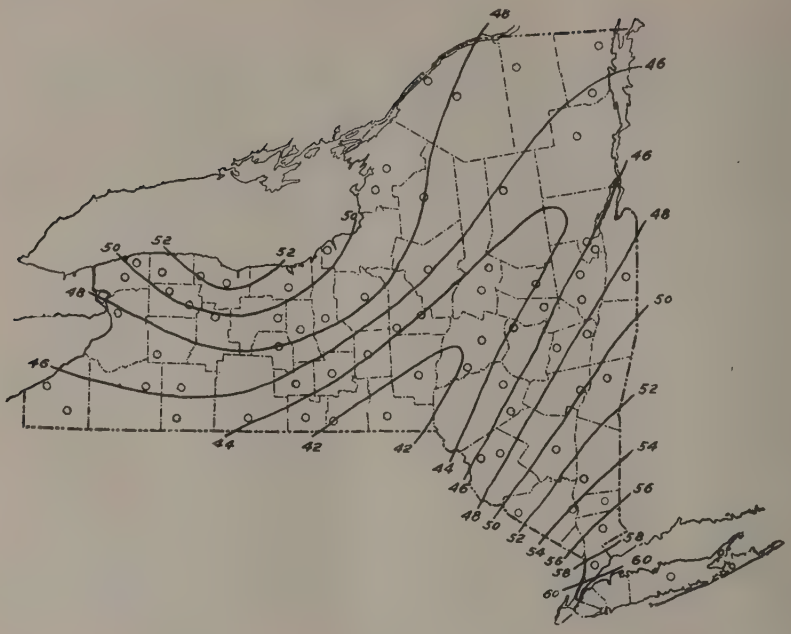

FIGURE 38. ANNUAL SUNSHINE (PERCENTAGE OF POSSIBLE)

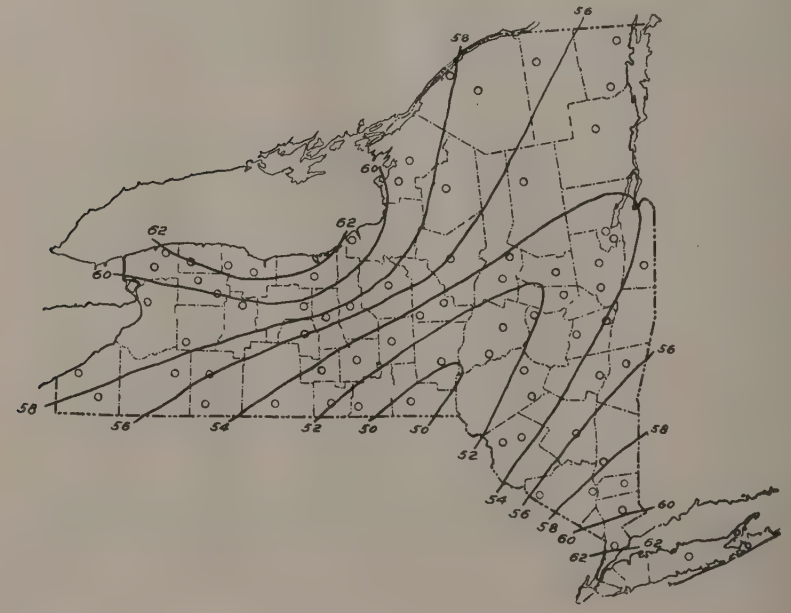

FIGURE 39. MEAN SUNSHINE FOR GROWING SEASON (PERCENTAGE OF POSSIBLE)

eastern cloudy belt, which includes the northern Appalachian Mountains, the Great Lakes region, and northern New England. However, the percentage of sunshine is somewhat higher during the summer months than during the winter months. This is a distinct benefit to the agricultural industries of the State.

The charts of the annual sunshine, and the sunshine during the growing season, are given as figures 38 and 39. These charts clearly show the conditions regarding sunshine throughout the State.

HUMIDITY

The amount of moisture in the atmosphere is usually expressed in terms of relative humidity, or the percentage of moisture in the air as compared with the amount that the air could hold at the same temperature. The capacity of the air for moisture increases rapidly as the temperature increases. Thus the relative humidity would normally be higher during the cooler part of the night than at midday, when the temperature is higher.

The mean relative humidity at eight o'clock in the morning, for the regular Weather Bureau stations throughout the State for the five-years period from 1915 to 1919, is given in table 3. While these figures are for one hour only, and do not necessarily represent the true daily mean, they do indicate that the atmosphere of the State is not deficient in moisture.

CHANGE IN CLIMATE

Many persons think that the agriculture of the State is changing, due to a change in the climate. It is well known that there have been great climatic changes during the past geologic ages, and, in all probability, there will be other changes in ages to come; but such changes are so gradual that they cannot be detected in any of the records at present available. The temperature and precipitation records for Albany, New York, by five-years periods beginning with 1820, are given in table 4. This table shows irregular fluctuations from period to period, but it shows no great change in the climate during the past one hundred and five years. Therefore any change in agriculture or in crop yields should be attributed to some cause other than a change in the climate of the State.

TABLE 3. MEAN MONTHLY RELATIVE HUMIDITY*

(Percentage)

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean annual
Albany	80.4	79.0	76.0	72.4	69.6	72.2	76.8	77.6	82.0	81.6	77.4	80.4	77.1
Binghamton	84.0	83.4	80.2	80.8	83.2	84.2	84.4	86.2	90.0	87.2	82.4	85.8	84.3
Buffalo	83.4	81.8	79.6	77.8	82.8	74.6	76.4	76.8	78.4	79.2	81.2	83.4	79.6
Canton	87.0	87.0	81.2	77.6	75.0	75.0	75.0	79.2	80.6	83.0	83.2	86.0	80.8
Ithaca	81.8	82.4	78.4	74.6	72.8	74.4	77.6	80.0	79.8	80.0	78.2	82.7	78.5
New York	68.0	67.0	64.4	65.8	68.0	73.2	76.2	77.0	75.6	75.6	70.0	71.6	71.0
Oswego	84.6	85.8	79.2	77.8	76.0	76.8	76.8	77.8	78.2	78.4	77.6	84.8	79.5
Rochester	79.4	76.6	71.6	70.0	69.6	70.0	72.4	75.2	76.2	77.0	74.4	77.2	74.1
Syracuse	80.8	81.2	76.4	71.2	70.2	74.4	79.2	78.6	79.0	77.0	78.0	82.4	77.4

* Five-years average (1915–1919).

TABLE 4. EARLY RECORDS AT ALBANY, NEW YORK

Period	Temperature (degrees Fahrenheit)			Precipitation (inches)		
	January	July	Annual	January	July	Annual
1820–24	21.8°	72.6°	48.5°	.....	.....	.....
1825–29	25.0°	72.8°	50.0°	3.66	4.89	39.66
1830–34	24.2°	72.6°	48.8°	2.37	4.18	40.01
1835–39	23.2°	71.8°	46.4°	3.72	3.94	41.48
1840–44	23.8°	71.9°	48.1°	2.30	3.22	42.14
1845–49	26.0°	73.0°	49.3°	2.46	4.44	41.12
1850–54	24.9°	72.8°	48.3°	2.07	4.52	39.66
1855–59	23.5°	72.0°	46.8°	2.14	4.17	37.90
1860–64	25.2°	71.9°	47.2°	3.02	4.71	35.45
1865–69	18.4°	74.6°	46.8°	2.31	3.11	38.97
1870–74	28.7°*	73.4°*	47.8°*	3.08	6.98	45.81
1875–79	19.4°	71.6°	46.5°	2.53	4.41	40.11
1880–84	23.9°	73.1°	50.1°	2.77	4.19	36.18
1885–89	22.4°	73.1°	47.7°	3.13	3.17	38.45
1890–94	24.5°	72.0°	48.4°	3.44	3.62	38.38
1895–99	23.0°	73.5°	49.0°	1.94	3.60	33.23
1900–04	22.4°	72.9°	48.1°	1.79	3.90	34.78
1905–09	25.1°	73.0°	48.1°	1.94	3.42	29.90
1910–14	24.7°	73.3°	48.6°	2.18	2.33	29.78
1915–19	24.9°	72.9°	48.0°	2.04	3.13	33.16
1920–23	20.4°	72.4°	49.1°	2.26	3.65	34.68

* Temperature for two years only.

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